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# Implications of the new manufacturing environment for management control system design

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## Abstract

The modern manufacturing environment is characterized by intense international competition, rapid product innovation, turnover and obsolescence, increased use of automation, and significant organizational changes in response to new manufacturing technologies. It is generally accepted that these changes in the manufacturing environment should be accompanied by changes in performance evaluation and reward systems to derive higher performance. However, it is very complicated to identify the required design of a management control system in such a new environment.

This paper gives a review of the relevant conceptual and empirical research in this field. It is concluded that evidence on the extent to which organizations have aligned management control systems with the manufacturing environment is both limited and inconclusive. Furthermore, some problems and issues related to the existing literature are addressed and perspectives for future research are indicated. The paper ends with propositions about the relationship between manufacturing environment and choice of management control systems.

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## **1. Introduction**

Manufacturing is undergoing many significant changes. The mass production model is being replaced by a flexible multiproduct firm that emphasizes quality and speedy response to market conditions while using technologically advanced equipment and new forms of organization (Milgrom & Roberts, 1995). In this new manufacturing environment, the traditional cost accounting models are no longer considered relevant, as they are based on an assumption of long production runs of a standard product with unchanging characteristics and specifications (Kaplan, 1983). Some authors even state that redesigning cost accounting systems is overdue considering that they have not changed since the early 1920s (Johnson & Kaplan, 1987). In addition, the traditional management accounting practices have been criticized as being inadequate to meet the needs of 'modern manufacturing' and for not promoting quality improvements, manufacturing flexibility, and innovation (e.g., Howell & Soucy, 1987, Daniel & Reitsperger, 1991). Others observe a change in scope taking account of a wide variety of changes that are occurring in high technology manufacturing and service firms. They state that notions about the role of management accounting information, traditionally only relating to labour, materials, and overhead, have expanded to include information about technologies, quality, innovativeness, and flexibility (Young & Selto, 1991).

It is generally accepted that changes in the manufacturing environment should be accompanied by changes in performance evaluation and reward systems to derive higher performance (e.g., Parthasarthy & Sethi, 1993; Milgrom & Roberts, 1995; Abernethy & Lillis, 1995). The idea that the design of a management control system depends on elements of the firm's context dates back to the work of Khandwhalla (1972), who studied the effect of different types of competition on the use of management controls. More recently, organization theory has come to view organizational strategy as perhaps the pre-eminent determinant in the design of organizations, but conceptual as well as empirical investigations on the linkages between strategy and control systems are very scarce (Govindarajan & Gupta, 1985).

Since the work of Skinner (1969), manufacturing is recognized as important in the overall strategic mission of the firm. Thus, manufacturing is of critical importance for a firm's strategy, and strategy is a crucial determinant of the design of organizations. This gives rise to the idea that the relation between manufacturing and management control systems is very relevant. Likewise, there is some recognition that accounting system choices depend on physical production characteristics, through the key physical characteristics are not specified (Karmarkar, Lederer and Zimmerman, 1990). However, there has been little

systematic empirical study of the link between manufacturing and control system design (Abernethy and Lillis, 1995). Therefore, manufacturing environment characteristics and their relation to control system design deserve research attention.

The aim of the present study is to review and discuss the literature that addresses the relationship between manufacturing environment, including manufacturing strategy and manufacturing technology, and important aspects of management control systems: financial as well as non-financial measures of performance and the relation between performance measures and incentive systems.

This paper contains six sections. The second section reviews the conceptual literature on the relation between the manufacturing environment and the management control system. Section three addresses the distinction between the old and the new manufacturing environment, because the new environment is expected to place different demands on management control systems. Subsequently, the fourth section gives an overview of relevant empirical research in this field. Section five deals with an evaluation of the literature and provides suggestions for future research. The last section discusses the conclusions.

## **2. The relation between management control and manufacturing environment**

This section deals with the relation between management control and the manufacturing environment. First, the domain of management control is described. Subsequently, the problems that result from a management control system that is not aligned to the situation of the new manufacturing environment are addressed.

### *Management control*

The word 'control' is probably one of the most ill-defined in the English language, having a wide range of connotations, from 'manipulate' through 'inspect' to 'prohibit' (Otley, 1987). Three types of information are usually needed to control a company: First, scorecard questions can be asked: How well are we doing? Second, attention-directing questions can be posed: What problems should we look into? Finally, problem solving questions are directed at: What is the best way to do the job? (Simons, 1954).

Management control has been defined by Anthony (1965) as the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives. In order to see what constitutes a management control system it is interesting to follow the agency perspective. Following this perspective, it is asserted that because all individuals

in a firm are self-interested, simply delegating decision rights to them and dictating the objective function that they have to maximize, is not sufficient to accomplish the firm's objective (Jensen & Meckling, 1992). Therefore, a control system that ties the individual's interest more closely to that of the organization is required.

Jensen & Meckling (1992) distinguish between specific knowledge (knowledge that is costly to transfer) and general knowledge (knowledge that is inexpensive to transmit). Getting specific knowledge used in decision-making requires decentralizing many decision rights. This creates a rights assignment problem and control problem. In markets the control problem is solved by granting alienability of decision rights to decision agents. A right is alienable if its owner can sell that right and capture the proceeds offered in the exchange. Voluntary exchange creates a process in which the purchase and sale of rights by maximizing individuals collocates knowledge and decision rights. In firms, it is not possible to alienate decision rights, so a control system is needed. The control system specifies (a) the performance measurement and evaluation system for each subdivision of the firm and each decision agent, and (b) the reward system that relates the individual's rewards to their performance.

Furthermore, Anthony's framework strictly separates management control from strategic control as well as from operational control. A negative side-effect of this strict categorization is that the focus is fixed almost only on senior management, and the lower levels are not addressed.

"The continued focus on senior management's use of controls could be misplaced. The success of a strategy may be directly influenced by activities that take place in other areas of the business, for example at the operational, and R&D areas of the business" (Langfield-Smith, 1997).

According to Otley (1994), the function of management control should no longer be primarily located at a specific (i.e. middle) managerial level, but needs to be embedded at all levels.

Furthermore, Anthony's definition of management control encourages a strong concentration on accounting-based controls. Of course, the management accounting system provides an aid to managers attempting to control a set of activities for which they are responsible. And, according to Watts & Zimmerman (1986), accounting numbers are used to control agency problems, besides providing information for making operating decisions. The following accounting systems can be mentioned in this respect: responsibility accounting, transfer pricing, executive compensation plans, and budgeting systems. However, the focus on only accounting controls is very narrow; a broader view on control would give the opportunity to

include a wider range of control activities. Otley (1994) makes some suggestions about control activities that need attention in contemporary organizations ranging from the selection of personnel, management and organizational development practices and business process re-engineering techniques to the more traditional ideas of performance measurement and appraisal, but even here aspects such as balanced scorecard performance measures, systems of mutual accountability and performance-related rewards need to be included.

### *Changes in the role of management control*

A modern manufacturing environment reasonably requires a management control system that is tailored to fit the specific circumstances of this kind of organization. This view is consistent with the so-called contingency theory of management accounting (Otley, 1980), which suggests that the most appropriate control system for an organization depends on certain contingent variables, e.g., environment, technology, organizational structure, and strategy. However, it is often noticed that companies' management accounting and control systems are not adequately attuned to the manufacturing environment.

"It is very important to deal with the difficulties resulting from management control systems that are not adapted to the new manufacturing environment. The use of outmoded management accounting information may serve as a major impediment to realizing the benefits of new manufacturing methods because the performance of individuals, production processes, organizational subunits, and firms in high technology environments cannot be accurately assessed and appropriately evaluated" (Young & Selto, 1991).

In a modern manufacturing environment, several accounting controls, the budgeting system, as well as compensation schemes deserve special attention. The use of non-financial measures of performance in the control system is also a matter of concern. In a general context, Zimmerman (1995, p.159) states that non-financial measures provide information for decision management (initiation and implementation) and financial measures of performance tend to be for decision control (ratification and monitoring). The application of this insight to companies operating in a modern manufacturing environment, yields some very interesting perspectives. It does not agree with the opinions expressed in the accounting and organizational control literature.

In this literature, it is often argued that companies that pursue new strategies and act in new competitive realities have to shift from treating financial figures as the foundation for performance measurement to treating them as one element in a broader set of measures (e.g, Eccles, 1991). And, it is believed to be vital that the management accounting system supports the management behaviour necessary to satisfy the order-winning criteria defined in the manufacturing strategy. Management control systems often provide the key criteria by which an operations manager is evaluated. In addition to the performance measurement system, the reward system is an essential element of the control system. Thus, to measure only the non-financial aspects is not enough. Many companies have kept track of non-financial measures for years, but they do not get equal status in determining promotions, bonuses, and other rewards (Eccles, 1991). According to Eccles, these companies should keep in mind that "what gets measured gets attention, particularly when rewards are tied to the measures".

Nanni et al.(1988) discuss three shortcomings of the current systems in the new manufacturing environment:

- 1) Measurement becomes obscured by overhead allocation not based on cause and effect. Many expenditures included in overhead are taken together and put in a cost pool that is spread over a set of existing products. The problem is made worse by an implicit notion of causation in the allocation base. Acceptance of cost control system's logic although not really based on cause and effect may lead to inappropriate judgments.
- 2) Data are collected and grouped by organizational unit only, instead of by other entities, e.g. expenditure goal, application, or strategy. So, vertical hierarchy and boundaries between organizational units are emphasized. The focus on task segregation when using responsibility accounting and variance analysis is opposite to the cross-functional coordination required to meet customer-driven demands, also consider Abernethy & Lillis (1995).
- 3) Overemphasis on financial reporting goals and physical output. The overemphasis on financial reporting goals is recognized by many authors. Fry et al. (1995) assert that management accounting systems, especially standard cost systems, are strongly related to financial reporting. As a consequence, operations managers tend to overemphasize plant financial performance and ignore other more indicative criteria.

Also Fisher (1994) mentions some of the problems associated with controlling a high-tech organization using a standard cost system. Some weaknesses are regarded as inherent in a standard cost system, while other deficiencies deal with implementation of standard cost systems:

- ◆ variances are not actionable at the operating level;

- ◆ the numbers are too summarized and too aggregate;
- ◆ overreliance on labour and machine hours;
- ◆ dysfunctional activities from overreliance on individual variances;
- ◆ setting standards is difficult in a changing environment;
- ◆ standards conflicted with the idea of continuous improvement;
- ◆ standard cost systems fail to provide timely signals.

The firms studied did not do away with their standard cost systems, as they were still needed for GAAP reporting purposes. However, the companies stopped the wide dissemination of the standard cost reports and little managerial attention or control was given to standard cost results.

Howell and Soucy (1987) argue that the new manufacturing environment should result in major changes to a firm's cost accounting system. The systems must be designed to focus on actual costs, different layers of cost variability, and the individual product. According to these authors, the use of standard costs for control purposes becomes unnecessary. The reason is that if the manufacturing process is of the high quality level intended, actual costs incurred should approximate the standard costs. Furthermore, variances from plant production performance such as scrap and rework will be recorded but on a real-time rather than on a delayed basis.

In summary, the above arguments suggest that several changes in management control systems are necessary for companies working in the new manufacturing environment. Thus, the changes in the manufacturing environment are considered relevant for management control system design. The literature always refers to these changes as the new or modern environment. The distinction between the old and the new environment raises the issue what are the distinguishing elements of a new manufacturing environment and how can such a new environment be recognized.

### **3. The manufacturing environment**

The developments in the manufacturing environment that are relevant with regard to the design and use of management control systems will be discussed in this section. In addition, the distinction between the old and the new manufacturing environment will be addressed. The reason to focus on this distinction is the notion that the new manufacturing environment is expected to place different demands on management control systems.

This new manufacturing environment is a combination of new strategies, technologies, and organizational forms (Milgrom & Roberts, 1990). Therefore, this section deals with the distinction between old and new manufacturing strategies,



and between old technologies and organizational forms and new technologies and organizational forms. Finally, the relation between these elements is analyzed.

### *Manufacturing strategy*

There is a growing recognition of the need to position manufacturing appropriately for competitive advantage and an increasing call for the strategic management of manufacturing (Skinner, 1986; Hayes et al., 1979a, 1979b). The consensus appears to be that this can be achieved by developing a manufacturing strategy which is consistent with the business strategy of the firm (Anderson and Schroeder, 1991).

A manufacturing strategy is assumed to be a part of an accepted hierarchy of strategies at the corporate, business, and functional levels. This hierarchy does not mean that a functional strategy is only reactive towards higher-level strategies; the functional area can also have a strategic influence. Furthermore, the term covers more than formulated strategy: it also includes an emerging pattern of actions and decisions (Mintzberg, 1978).

Manufacturing strategy can be defined as the effective use of manufacturing strengths as a competitive weapon for achieving business and corporate goals. Most definitions refer to building or positioning resources in a way that enhances a firm's competitive position in the marketplace (Swink and Way, 1994). The dimensions of manufacturing strategy mentioned in the manufacturing strategy literature are (1) cost, (2) quality, (3) flexibility, and (4) dependability (Wheelwright, 1984). Slightly different categorizations are also used. Chase et al. (1992) argue that service should be considered a fifth competitive dimension unrelated to dependability. Service pertains to a factory's ability to enhance the firm's relationship with its customers by providing information to other internal functions (e.g., R&D, marketing) by problem solving, enhancing sales, and through after-sales support.

Parthasarthy and Sethi (1993) analyze three strategy types that are directly related to manufacturing competencies: cost leadership, quality leadership, and flexibility. Cost leadership refers to a firm's desire to be the most efficient producer in the industry. The manufacturing approach associated with this strategy involves long production runs with minimal or no changes in product design. Quality leadership refers to the firm's focus on industry recognition based on product design and performance. Flexibility refers to the firm's intentions to compete in one or more markets based on product innovation in a cost effective manner. Two types of flexibility are defined and analyzed here: scope and speed or change-over flexibility. The former involves competing on product variety and volume

flexibility. The latter entails frequent new product introductions, speed in innovation, etc.

The latter is also referred to as a fourth market requirement, 'innovation' by Bolwijn & Kumpe (1990). These authors introduce a phase model, describing the evolution of companies as they move from the efficient firm (1960s) to the quality firm (1970s) on to the flexible firm (1980s) and, finally, to the innovative firm (1990s). Important elements of this model are the sequential development of market requirements (you cannot be innovative without being flexible, and quality is a necessary precondition for flexibility) and the strong interrelations between the performance criteria (each new set of characteristics is an extension of the old one, also reinforcing the old one).

To conclude, different dimensions of a manufacturing strategy are distinguished. These dimensions can be used to indicate the differences between the old and the new manufacturing environment. The phase model of Bolwijn and Kumpe may be helpful in this regard. Thus, in the old manufacturing environment an exclusive emphasis on the cost dimension is assumed. In the new environment, a manufacturing strategy that emphasizes also the other dimensions, namely, quality, flexibility, dependability, and service, is expected. However, taking a slightly different perspective, we might categorize both the efficient firm and the quality firm in the old environment, as probably these are both bureaucratic and mechanistic organizations. Hence, drawing rigid lines between the old and the new manufacturing strategy is difficult, especially because in reality each company is a mixture of the ideal types outlined.

### *Manufacturing technology and organizational form*

The origins of the currently used typologies of manufacturing processes can be traced back to the work of Woodward (1958, 1965), which demonstrates that in manufacturing firms, production technology has a systematic relationship with (organizational) structure and management characteristics. Woodward uses three primary categories: (1) small batch and unit production; (2) large batch and mass production; and (3) process production.

Hayes & Wheelwright (1979a, 1979b) used four process categories: job shop, batch, assembly line, and continuous flow. In this classic categorization, many of the characteristics of productive units are a function of two primary dimensions with complementary life cycles - process structure and product structure. In the manufacturing literature, the relationship between the process structure and product structure is often expected to provide a basis for exploring some of the strategic options from a manufacturing perspective. Accordingly, it might be used to

distinguish between old and a new manufacturing environments in this study. Thus, a job shop and batch would presumably be considered old technologies, and, assembly line, and continuous flow would be regarded as new technologies. However, it is rather difficult to draw a rigid boundary, especially since a job shop is often used for specialty products in high-tech environments.

A reason for this difficulty is that this traditional classification scheme is presently losing its applicability. In a broader sense, the difficulty is the result of changes in manufacturing technology which have altered the meaning of some of these traditional labels associated with process structures. For example, traditionally discrete parts manufacturing was generally organized in batch or assembly line environments. However, with the introduction of flexible manufacturing system (FMS) concepts, these structures now share some of the same characteristics of continuous flow environments and some of the characteristics of job shop environments (Kotha & Orne, 1989). These developments in manufacturing technology can be compared to developments like material requirements planning (MRP) and just-in-time (JIT). Systems like MRP and JIT are operations management systems that quite clearly can change the way the factory is managed. The application of JIT, for instance, gives a traditional job shop some of the characteristics of a continuous flow environment. Dependency between processes will increase since work-in-progress (WIP) is no longer used as a buffer.

The typologies developed to date are all very similar: each identifies manufacturing structures by attributes of the product (i.e., volume, variety, complexity), process (i.e., span, complexity, flow) and market (i.e., scope, need, diversity). Therefore, two fundamental questions are relevant: 1) are the dimensions used to describe manufacturing types adequate to specify commonly occurring manufacturing structures? and 2) do generic manufacturing types adequately describe superior competitive forms? (Swink & Way, 1994)

Consequently, for a distinction between the old and the new manufacturing environment, the influence of the operations management system should be kept in mind, and should also be incorporated in an operational model that categorizes manufacturing technologies. The work of Kim and Lee (1993) should be noticed in this respect, as it deals with a taxonomy of processes based on technical flexibility and technological complexity. They relate the newer manufacturing technologies such as flexible manufacturing control (FMC) and flexible manufacturing systems (FMS) to the traditional processes used by Hayes and Wheelwright (1979a, 1979b).

### *Relation between manufacturing strategy and manufacturing technology*

Despite the wide recognition of the importance of fit between technology policies and business strategy, this relationship has not been well documented empirically in the literature (Capon & Glazer, 1987, Zahra & Covin, 1993). Consequently, little evidence exists about how technology policy relates to business strategy and, ultimately, to company performance. More fundamentally, there is no agreement on the content of technological policies, which makes it difficult to evaluate their contribution as a source of competitive advantage. Furthermore, the bulk of the literature in this area is conceptual in nature, and empirical studies to date have focused on the larger, powerful firms (or their divisions) rather than their smaller and more numerous counterparts (Zahra & Covin, 1993).

Hence, the need to link technology with business as well as manufacturing strategy is recognized. This link might be elaborated for automation technology. Because different automation types possess different processing capabilities, a correspondence is required between the strengths of the chosen automation on the one hand, and business strategy and organizational choices on the other. Therefore, it is necessary to distinguish between fixed automation, used to achieve process efficiencies, and flexible automation, like computer aided design (CAD), computer aided manufacturing (CAM), and computer integrated manufacturing (CIM), used to facilitate discrete production due to programming facilities (Parthasarthy & Sethi, 1992). Flexible automation makes variety production possible at costs that were previously only realizable through long production runs of standardized products. Automated technology can thus be a tool for implementing a flexibility strategy. Additionally, flexible manufacturing systems may allow a firm to operate with a simultaneous emphasis on the variables associated with both customer responsiveness and standardization (Bowen et al., 1989).

Thus, a distinction is made between automation that supports the mass production organization and automation attuned to the flexible production organization. Furthermore, the distinction between a mass production organization and flexible manufacturing organizations is expected to have implications for strategy formulation and organizational design (Nemetz & Fry, 1988). Accordingly, the distinction between a mass production organization and a flexible production organization will influence many different company characteristics (Milgrom & Roberts, 1990; Milgrom & Roberts, 1995). The authors introduce the *complementarity principle*, the notion that doing more of one activity increases the benefit of doing more of the other activity (e.g., flexible machines complements a flexible product line, short production runs, low inventories, a make to order situation, very skilled workers, etc.). This notion encourages the idea that it is

worthwhile and valid to focus on the difference between the old and the new environment. It supports the idea of a strict division of firms operating in the old environment and companies in the new environment, which consequently has its implications when we think about aligning a company's management control system to its environment.

The complementarity principle explains the difficulty in changing from the traditional to the new manufacturing environment as well. To effect change, an organization has to be centrally directed, since many aspects have to be altered simultaneously (Milgrom & Roberts, 1995). Nemetz & Fry (1988) also notice that it is not difficult to see why transition to the new environment will be difficult: change is always difficult to implement, but it is particularly difficult for organizations that have been designed to be rigid and invariant. Such organizations must respond by replacing their current mechanistic structures with structures that are more organic. Also, needed investments in e.g. flexible product lines will influence the time needed to change the organization. The companies that are able to transform their manufacturing organizations into sources of competitive advantage are those that can harness various improvement programs to the broader goal of selecting and developing unique operating capabilities (Hayes et al., 1993). These common difficulties can be used to explain the existence of companies with characteristics that are not complementary.

Summarizing, the distinction between the old and the new manufacturing environment has been addressed, because it is considered relevant for management control system design. The complementarity principle encourages the idea that the distinction between the old and the new manufacturing environment is worthwhile when a suitable management control system has to be designed. One basis for this distinction relates to the manufacturing strategy: is the emphasis placed exclusively on costs or also on other dimensions (e.g., quality, flexibility, dependability, and service)? Furthermore, the classic categorization of production processes (job shop, batch, assembly line, and continuous flow) is regarded as not sufficiently up-to-date to be distinctive, and, it is suggested to include operations management system orientation and automation approach (for mass production or for flexible production). For research purposes a proper terminology and typology specifically related to the new manufacturing environment is needed, as developments in automation and operations management make the conventional terminologies and typologies less adequate.

In the next section, a review is presented of the empirical research that studies the relationship between management control systems and manufacturing environment.

#### **4. Empirical research**

"How is it that an activity of such obvious complexity can be coordinated and controlled so that it continues to meet the needs of those having an interest in it?" (Otley, 1987).

These words refer to control problems in organizations. Control problems can also be observed in contemporary complex manufacturing settings. However, investigating the role of accounting information in the more complex production and assembly operations of contemporary manufacturing settings is a subject that has not received enough research attention (Kaplan, 1984). This section provides an overview of empirical research published since 1984 on the relation between manufacturing environment and management control system design. Note that none of the studies reviewed, specifically focuses on the distinction between the old and the new manufacturing environment. Only individual aspects of manufacturing strategy or manufacturing technology are addressed in these studies. Table 1 presents an overview of the empirical research studies reviewed. These studies have one or more independent variables describing 'Manufacturing strategy' and/or 'Manufacturing technology', whereas 'MCS characteristics' are the dependent variables. For the studies that also measured performance, the performance measure is described in the column 'Performance'.

##### *Manufacturing strategy and management control*

One of the first empirical studies that explicitly examined the relationship between strategy and control systems was by Govindarajan & Gupta (1985). They studied the effects of linking the strategic business units (SBUs) general manager's incentive system to SBU strategy on SBU performance. Thus, the SBU strategy was examined rather than the manufacturing strategy. A result of the study is that a greater reliance on long-run criteria as well as on subjective bonus systems enhances the effectiveness of build SBUs but hampers the effectiveness of harvest SBUs. The study shows that the relation between strategy and management control systems can affect performance and that organizations adapt their systems to meet the requirements of the situation.

	Manufacturing Strategy	Manufacturing Technology	MCS characteristics	Performance
Govindarajan & Gupta (1985)	BU-strategy: varies from pure build to pure harvest		<ul style="list-style-type: none"> <li>- incentive system: long-run vs short-run</li> <li>- quantitative formulas vs subjective discretion</li> </ul>	<ul style="list-style-type: none"> <li>subjective : 12 dimensions</li> <li>- importance</li> <li>- comparison of actual with expected performance</li> </ul>
Karmarkar, Lederer & Zimmerman (1990)		<ul style="list-style-type: none"> <li>- production process (continuous, batch flow)</li> <li>- product complexity</li> <li>- number of products</li> <li>- instability of the production process</li> </ul>	<ul style="list-style-type: none"> <li>- number of overhead cost pools</li> <li>- standard cost variances reported</li> <li>- frequency and reporting lag of accounting reports</li> <li>- degree of reporting performance evaluation data</li> </ul>	
Brownell & Merchant (1990)	product standardization	process automation (Inkson et al. instrument, 1970)	budgetary participation flexibility of budget targets	self-rating of performance compared with other departments
Daniel & Reitsperger (1991)	innovative vs traditional quality strategy		quality goals and feedback about rejects and downtime	
Dunk (1992)		process automation (Inkson et al. instrument, 1970)	budgetary control (Hopwood instrument, 1972)	self-rating of performance compared with other departments
Fry & Steele (1995)	primary order winning criterion		standard cost-systems	
Abernethy & Lillis (1995)	manufacturing flexibility			self-rating of performance compared with other departments
Ittner & Larcker (1995)		TQM practices	non-traditional performance and reward systems	<ul style="list-style-type: none"> <li>- self reported ROA</li> <li>- product quality</li> </ul>
Durden (1996)		JIT versus non-JIT users	use of non-financial performance indicators	<ul style="list-style-type: none"> <li>subjective: 7 dimensions</li> <li>- importance</li> <li>- comparison of actual with expected performance</li> </ul>

*Table 1 Research design of empirical studies of manufacturing environment and MCS characteristics*

Brownell & Merchant (1990) studied the issue of how product standardization influences the relations among budgetary participation, flexibility of budget targets, and departmental performance. The idea was that for standardized products the optimal input/output relation is either known or can be learned as opposed to being a matter of negotiation between budgeted managers and their superiors. Also, the assumption about flexible budgeting was that cost/volume relations are understood well enough to permit sensible, volume-based budget adjustments. The results suggest that the product dimension significantly affects the relationship between each of the budgeting variables and performance. Where product standardization is low, high participation and use of budgets as static targets are each found to be significantly more effective in promoting departmental performance than if product standardization is high.

Daniel & Reitsperger (1991) investigated the relationship between innovative quality strategies and management control systems. The data show that quality goals and feedback about rejects and downtime are more frequently provided to managers adhering to a zero-defect strategy.

The relationship between manufacturing strategy and use of a standard costing system was examined by Fry & Steele (1995). The results suggest that the primary order-winning criterion for users of standard cost systems is product quality. The primary order-winning criterion for non-users is product-price/cost. These results are somewhat contrary to the recommended use of standard cost systems, which are considered the most applicable when product price is the primary order-winner; this is understandable given its emphasis on controlling costs. A possible explanation for the observed inconsistency is operations managers lack of understanding of the management accounting system and the behaviour it encourages.

Abernethy & Lillis (1995) studied the impact of manufacturing flexibility on the design of management control systems, especially on the use of efficiency-based measures and integrative liaison devices. The results support the notion that organizations adapt their structural arrangements and their use of efficiency-based measures in order to implement manufacturing flexibility. The correlations between performance and use of efficiency-based measures were in the predicted direction for the two groups (positive for the non-flexible firms and negative for the flexible firms). An interesting point in Abernethy & Lillis' study is their development of two measurement schemes for measuring flexibility and integrative liaison devices. While the results provide some empirical evidence that the appropriate match between control system design and flexibility enhances performance, the authors warn that the qualitative data collected in the field suggest the need for caution in the interpretation as many other reasons for low performance are given by the



managers in the field. Furthermore, they remark that an attempt to measure the impact of "fit" on performance ignores the dynamic nature of organizations. Several firms had only recently gone through some changes or were in the process of changing either their strategy or control system design.

The findings of both Daniel & Reitsperger and Abernethy & Lillis confirmed the hypothesized relation between management control systems and manufacturing strategy, whereas Fry & Steele did not find the expected relation. The latter have no information on the effect of the apparent misfit on manufacturing performance. Daniel & Reitsperger have no information about performance effects either, although they conclude that companies striving to modify their management control systems may need to provide more goal-setting and feedback information about specific quality items; this conclusion would be more convincing if it was supported by performance data.

#### *Manufacturing technology and management control*

The central hypothesis in the study of Karmarkar, Lederer and Zimmerman (1990) is that the choices of cost accounting and production control systems are affected by characteristics of the firm's output market and production technology. The study consisted of five plant-visits and a questionnaire survey involving thirty-nine plants. The field studies generally confirm the hypothesis that the design of cost accounting and production control systems depends on the type and stability of the production process and the importance of overheads and competition faced by the firm. The authors point out the complicated nature of the relation between market conditions, the production process, and cost systems and the difficulty of measuring important independent and dependent variables. From the survey, only a few empirical associations were found between costing and production control systems and the hypothesized independent variables. There are several possible explanations for the lack of stronger findings: (1) The survey instrument was noisy. Meaningful terminology to classify accounting and control systems and types of production processes was lacking, (2) Furthermore, the *a priori* expectations of relations may have been incorrect, and (3) The tests are also weak if the production control and accounting systems are slow to adapt to current production modes. Statistically significant associations between the dependent and independent variables are not observable if adjustment lags are prevalent.

Brownell & Merchant (1990) studied the question of how manufacturing process automation influences the relations between budgetary participation, flexibility of budget targets, and departmental performance. The *ex ante* idea about the effects of process automation on the relation between participation and departmental

performance was that this relationship is unclear. On the one hand, process automation is expected to increase control over manufacturing processes through the direct incorporation of control mechanisms into the manufacturing technology itself. Automated controls could, therefore, reduce the need for budgetary controls and, hence, for managerial participation in setting budgets. On the other hand, manufacturing facilities are expected to provide the manager with choices in such matters as work scheduling. To the extent that these choices have cost implications, the manufacturing manager has more scope for a meaningful participation in setting budget targets than in the case of traditional technology which precludes choices on matters like work schedules. The results suggest that the process dimension does not significantly affect the relationship between each of the budgeting variables and performance. The authors write that the dimension is either unimportant or poorly measured. Other process dimensions are mentioned, such as scheduling methods, design engineering methods, "just-in-time" inventory control methods, and the degree of flexibility of the manufacturing process, which could also influence the optimal budget system design. The operational measure of process automation is the three-part instrument developed by Inkson et al. The instrument was developed in 1970, so it may not adequately capture some aspects of a contemporary notion of automation. Other potential limitations are discussed, such as self-ratings of performance, the use of a single item to measure the use of budgets as static versus flexible targets, and the lack of control for different incentive schemes in the study.

Dunk (1992) hypothesized that, the higher (lower) the level of manufacturing process automation and the higher (lower) the reliance on budgetary control, the higher the production subunit performance. Manufacturing process automation was measured by the Inkson et al. (1970) instrument, which was also used in the study of Brownell and Merchant. Reliance on budgetary control was measured by a modified form of the Hopwood instrument (Hopwood, 1972).

The results of the study suggest that manufacturing process automation moderates the relation between reliance on budgetary control and production subunit performance. As manufacturing processes become more automated, companies benefit from relying on budgetary control. It is interesting to note the difference in findings between Brownell & Merchant (1990) and Dunk (1992) with regard to the effects of automation.

Ittner & Larcker (1995) examined two questions: 1) What is the relation between individual TQM practices and information and reward system attributes? and 2) Holding the level of TQM activity constant, do organizations making more extensive use of nontraditional information and reward systems achieve higher performance? Theory is supposed to say little about the appropriate match among

the individual TQM practices and performance measurement and reward systems attributes. Therefore, it is assumed that the observed empirical associations represent "best practice". The results suggest that TQM practices are related to nontraditional performance and reward systems that place greater emphasis on team and non-financial performance, more frequent provision of quality information to all organizational levels, and greater use of bottom-up data gathering techniques such as statistical process control. In companies with more advanced quality practices, external benchmarking of products, processes, and services is more frequent, strategic information is communicated more often, and reports on quality plans and achievements are reviewed more frequently by the board of directors. Mixed support exists for the claim that performance is the result of the interaction between TQM and performance/reward systems. Among less extensive users of formal quality improvement practices, greater reliance on nontraditional information and reward systems is associated with higher performance. However, no support is found for the proposition that nontraditional information and reward systems improve the performance of organizations with extensive formal quality programs. This latter result is inconsistent with normative prescriptions.

Ittner & Larcker argue that the TQM practices covered in the survey should be broadly representative of recent changes in manufacturing techniques, as these practices provide the foundation for other advanced manufacturing techniques such as just-in-time production, flexible manufacturing, and business process reengineering. This idea is partly confirmed by a study by Durden et al. (1996), which provides evidence for the claim that non-financial performance indicators are used to a significantly greater extent in firms operating in a JIT environment than in a non-JIT environment. However, it was found that increased use of non-financial performance indicators is associated with higher performance irrespective of whether the production management system is a JIT or a non-JIT system.

## **5. An evaluation of previous research and perspectives for future research**

"An important contribution of future studies will be determining how manufacturing strategy, organizational design, and specific management control choices such as compensation practices, performance measures, and cost accounting systems interact to determine organizational performance" (Ittner & Larcker, 1996).

The relation between the new manufacturing environment and management control has already received serious attention in the literature. However, there is a need

for more empirical research as the results have been inconclusive due to various shortcomings. The following criticisms, partly extracted from the literature mentioned above, are noteworthy:

- \* The operationalisation of the variable manufacturing strategy in most of the empirical research is very simple as e.g., only the number of product types are used as an indication of manufacturing strategy.
- \* The used classifications of technologies can be considered outdated. The use of production automation, flexible manufacturing systems (FMS), and new forms of production and inventory control (e.g., JIT), make these classifications unrealistic and impractical in a contemporary setting.
- \* A distinction between the presence of information and the *use* of this information for performance evaluation is important, especially as the increasing use of computer systems leads to information that can be made rapidly available against low costs. Managers cannot use all available information due to bounded rationality. The relation of performance measurement with incentive systems is useful here to discriminate between the availability of information and its application in performance evaluation.
- \* Most research only addresses the corporate and the business unit level. The manufacturing (or operations) level is seldom used as the unit of analysis. However, manufacturing is expected to be a source of competitive advantage for many companies.
- \* Many researchers address the relation between strategy and management control; only a few deal with the relation between technology and management control: there is clear lack of research into the interactive effect of strategy and technology on management control.
- \* With regard to management control systems, researchers mostly presume that either budgetary controls or other controls are in use. It might be interesting to postulate that in certain circumstances, both kinds of controls make a contribution, so that the additional control measures would complement budgetary control rather than supplant it (Dunk, 1992).
- \* Most empirical studies do not take into account the effects of a time lag between a change in circumstances and a change in management control systems, although this time lag may be expected to occur repeatedly.
- \* Management control systems are probably not only influenced by advanced manufacturing practices, but can also influence the strategic and organizational choices made by the organization. This is consistent with the literature on the interactive use of management control systems (e.g, Simons, 1990). Empirical research in this area is scarce.

These shortcomings in the current empirical research can be translated into interesting empirical research questions. Moreover, the contingency theory underlies a lot of research models. This usually means that relations between variables are investigated without a very articulate theoretical basis. A more elaborate theoretical basis before the phase of hypothesis testing will probably result in more meaningful findings. Economic and organizational theory might offer useful perspectives here, to mention the agency theory and the complementarity principle. An interesting example of such an approach is offered by the case-based research of Wruck & Jensen (1994). In this study Total Quality Management is analyzed from an economic and organizational perspective. Thus, the research perspective contains also some theoretical challenges.

To conclude, a lack of knowledge is observed about the relationship between the manufacturing environment and the design of management control systems. Therefore the following research question is considered relevant for future research:

*What is the effect of the new manufacturing environment on the design of the management control system, and do firms with management control systems aligned to the manufacturing environment achieve higher performance?*

The following subquestions are derived from this central research question: 1) What characteristics of the manufacturing environment influence the design of the management control system? Do these characteristics also have an interactive effect? 2) What aspects of the management control system are different in the new manufacturing environment? 3) What relations between manufacturing environment and management control system can be expected? and 4) Do firms with management control systems attuned to manufacturing strategy and manufacturing technology achieve higher performance?

It would be interesting to take the manufacturing (or operations) level as the unit of analysis, because management accounting and control systems are not always found to be consistent with manufacturing strategy and/or manufacturing technology. Empirical research on how performance measures and reward systems may be used in particular operational strategies, and to support new manufacturing philosophies, was also suggested as a research agenda for future study in a very recent article (Langfield-Smith, 1997).

The elements of the management control system that could be assumed to play a different role in the old versus the new manufacturing environment are shown in table 2. The design of the management control system that could be expected in the old and the new manufacturing environment with regard to these variables is also presented. However, these expectations still need to be elaborated as well as empirically tested.

management control dimensions	old manufacturing environment	new manufacturing environment
focus on financial versus non-financial performance measures	focus on financial performance measures	focus on non-financial performance measures
level of detailed/aggregated information	more aggregated information	more detailed information
emphasis on achieving budgeting targets	high emphasis on budget targets	low emphasis on budget targets
level of participation in setting the budgeting targets	low participation	high participation
emphasis on task segregation in performance measurement	high emphasis on task segregation	low emphasis on task segregation
focus on budgeted or actual costs	focus on budgeted costs	focus on actual costs
emphasis on efficiency versus emphasis on effectivity	emphasis on efficiency	emphasis on effectivity
use of allocated costs for performance measurement	much use of allocated costs	low use of allocated costs
focus on short-run versus long run criteria	focus on short-run criteria	focus on long-run criteria
use of subjective or objective criteria in the reward system	use of objective criteria	use of subjective criteria
use of variable components in the reward system	low use of variable components	high use of variable components

*Table 2 The expected MCS design in the old and new manufacturing environment*

In future research, these variables could be studied in companies operating in the old and the new manufacturing environment. Subsequently, the observed company practice could be compared with the expected MCS design. Although many authors suggest one or more of the MCS dimensions mentioned as being critical for the success of a company, a lack of empirical research in this area is evident. The same argument holds for empirical research that integrates all variables that distinguish between the old and the new manufacturing environment. Moreover, by comparing the results of several empirical investigations, it is concluded that the results are inconclusive on some issues, e.g., the effects of automation.

## **6. Conclusions**

Many accounting researchers suggest that the modern manufacturing environment puts different demands on management control systems. A review of the literature teaches that an operationalisation of the relevant variables in the new manufacturing environment is a complex matter. A meaningful set of terminology to classify types of production processes is lacking. Furthermore, empirical research in this area is scarce, especially at the manufacturing level, shows several limitations, and is inconclusive on several aspects. In addition, the empirical studies reviewed only address the individual aspects of a new manufacturing environment. The distinction between the old and the new manufacturing environment is not specifically addressed in these studies, though it is an important subject for research.

Hence, a suggested potential area for research concerns the manufacturing level, because it is relevant to examine the effects of the manufacturing environment on management control system design. Both case-studies and survey research may have a contribution here. Case-studies will provide a basis for understanding which variables are relevant and why, while survey-based research is very needed as many of the ideas that are expressed in the conceptual literature have not yet been tested statistically. Survey research is also worthwhile when we want to study whether firms with management control systems aligned to their manufacturing environment achieve higher performance. Furthermore, the use of a more articulate theoretical basis for both kinds of research is recommended, because it makes the interpretation of the results more valuable; organizational theory has much to offer in this respect. In general, it is concluded that more empirical research is necessary to understand the changing role of management control systems in companies that operate in a new manufacturing environment.

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